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August 9. 1

Vol. 64, No. 32, Pages 497-504

Pickett, Okla,† Wilson et al. [1983]. Ghiorse and Balkwill [1982]. W. G. Ghiorse (personal communication, 1982). lln millions per gram dry material.

Biological

R.S. Kerr Environmental Research Laboratory, U.S. Environmental Protection

Recent investigations have discovered surpris-ingly high numbers of microorganisms in shal-lor water-table aquifers. Evidence is accumulat-

log water-range admicts. Extraction may, under cer-sis circumstances, transform many of the

enfronment. These transformations can lead to total destruction of the pollutant or to the pro-

The phenomenal expansion of the chemi-

cal industry in this century, and particularly

blessings and several new problems. Among

these is widespread pollution of groundwater

in industrial areas with organic contaminants

and the growing pollution of groundwater in

odes. The role played by microorganisms in

microorganisms in controlling the quality of groundwater has only recently become appar-

Groundwater is Part of

In early studies of the numbers of microbes

in soils, the microorganisms were counted by

spreading dilutions of subsurface material on

aculture medium and containg the colonies

ha developed. Because very few colonies de-

seloped from samples of soil taken below the

root zone, early microbiologists concluded

that this region of the earth was essentially

devoid of life [Waksman, 1916]. As a result.

an understanding of the true size and impor-

rance of the populations of organisms that oc-

Water Table,

3.6

the Biosphere

Lula, Okla.+

June 1881

fort Polk, La.†

Borehole 7

onroe, Texas‡

Long Island, N.Y.‡

the destruction of organic contaminants in

surface water has long been appreciated.

However, the importance of subsurface

agricultural areas with pesticides and herbi-

since World War II, has brought us many

organic pollutants that enter the substirface

uction of new organic pollutants.

Introduction

Agency, Ada, Oklahoma 74820

Transformation

in Groundwater

John T. Wilson and James F. McNabb

of Organic Pollutants

cur naturally in groundwater was delayed.

similar growth medium.

same site.

crobiologísts.

that could grow on nutrient agar or on some

Special staining procedures that distinguish cellular material from noncellular particles of

the same size and shape have been adapted to subsurface material [Ghiorse and Bulkwill,

1983]. After staining, the microbes can be counted directly in samples of subsurface ma-

terial with a microscope. The technique has

been applied to core material from several

shallow water-table aquifers and associated material from the vadose zone. These cores

were obtained by using special procedures

developed to provide uncontaminated sub-

surface samples [Wilson et al., 1983b]. The

numbers of organisms were surprisingly high (Table 1). Numbers did not decline drastically

formity of numbers at different seasons and

The population density of organisms in the

cores was comparable with the density of bac-

teria in nutrient-rich lakes [see Pedros-Alio and

Brock, 1982]. In fact, the total biomass in re-

gions below the root zone in North America

s probably much higher than the bacterial

piomass in the rivers and takes of our conti-

nent. Shallow water-table aquifers and associ-

are an important microbial habitat, which un-

til recently had been virtually ignored by mi-

electron microscopy to learn something of

their structure and taxonomy. When fine-

grained subsurface material was examined,

several morphological forms of bacteria were seen [Ghiorse and Balkwill, 1983; Wilson et al.,

1983b]. There was little evidence of yeasts or

other tungi, protozoa, or higher animals.

This makes the assemblage of bacteria in

these environments unique, because orga-

nisms that are important scavengers and

Just Above Water Table§

3.4 3.7

The groundwater microbes were studied by

ared regions of the vadose zone, therefore,

in material from replicate bore holes at the

with depth, and there was surprising uni-

TABLE 2. Prospect of Biotransformation of Selected Organic Pollutants in Water-Table

TABLE 1. Numbers of Organisms in the Subsurface Environment

Subsoil§

0.5

	Concent	Water, ration of nt, µg/l		
Class of Compounds	>100	<10°	Annerobic Wate	
Halogenated Aliphatic Hydrocarbons Trichloroethylene Tetrachloroethylene 1,1,1-Trichloroethane Carbon Tetrachloride Chloroform Methylene Chloride 1,2-Dichloroethane Brominated methanes Chlorobenzenes Chlorobenzenee 1,2-Dichlorobenzene 1,2-Dichlorobenzenee 1,4-Dichlorobenzenee 1,4-Dichlorobenzenee 1,4-Dichlorobenzenee 1,3-Dichlorobenzenee 1,3-Dichlorobenzenee 1,3-Dichlorobenzenee 1,3-Dichlorobenzenee 1,3-Dichlorobenzenees Benzene Toluene Dimethylbenzenes Styrene Phenol and Alkyl Phenols Chlorophenols Aliphatic Hydrocarbons Polynuclear Aromatic Hydrocarbons Town and three rings	none none none none none possible possible improbable probable	none none none none none improbable improbable possible possible improbable possible	possible* possible* possible* possible* possible possible possible possible probable none none none none none none none n	

predators in other natural systems, such as protozoa, are missing. Sands and gravels in river valleys may contain a wide variety of higher organisms [Danielpol, 1976]. Coarse material in upland landscapes is yet to be ex-

To confirm the results of the microscopic examinations, the biomass of organisms in the core material was also estimated by extracting and quantifying certain biochemical compounds that are usually restricted to living organisms [White et al., 1983]. The biochemical analyses for biomass, in general, showed good agreement with expected values based on cell numbers. Also in agreement with the direct count, the biochemical characterization failed to detect any of several biochemicals that are found in protozoa, fungi, or higher animals, but not in bacteria.

Recently, techniques have been developed that allow microbiologists to study all of the microbes in the subsurface and not just those The biochemical characterization of subsurface material is potentially a very powerful tool. Certain physiological groups of bacteria, such as the sulfate reducers or the methane bacteria, can be detected by the presence of cellular constituents that are restricted to that group. On the other hand, the general nutri-tional state of the entire biological community can often be inferred from the ratio of the quantities of certain biochemicals found in

Biotransformations of Organic Pollutants

Organisms in the deeper subsurface envi-ronment can transform many important or-ganic pollutants. The rate of transformation s limited by the numbers and activity of the microorganisms, while the extent of mansformation is most frequently limited by some requirement for metabolism such as oxygen.

pH buffering capacity, or mineral nurrients.

As a result, the biological fate of a particular class of organic pollutant is controlled by the geochemical properties of the subsurface environment. For example, Wilson et al. [1983a] and Wilson et al. [1983b] found no evdence for biological degradation of chlorinated aliphatic hydrocarbons in three shallow aerobic aquifers. On the other hand, Parsons [1983] showed that many of these compounds could be transformed in anaerobic subsurface material. In muck soil from Florida, carbon tetrachloride was transformed to chloroform. Similarly, tetrachloroethylene was transformed to trichloroethylene, then to all three dichloroethylenes and perhaps to vinyl chloride. In a study of the fate of halogenated hydrocarbons in treated municipal wastewater after injection of wastewater into an aquifer, Bonner et al. [1981] found that chloroform and several other halogenated methanes were transformed readily in the anaerobic water in the aquifer, and tri- and tetrachloroethylene disappeared at a somewhat slower rate.

The geochemical properties of the subsurface environment also limit the degradation of organic pollutants that are natural products, as opposed to synthetic industrial chemicals. Ehrlich et al. [1982] studied the fate of Water Table§ creosote waste in a contaminated aquifer and found that many phenolic compounds in the waste were being degraded to carbon dioxide and methane by an anaerobic consortium of bacteria in the aquifer. However, they found no evidence that polynuclear aromatic hydro-carbons such as naphthalene were being de-graded under anaerobic conditions in the

Predicting Degradation of Organic Pollutants

The relationship between the concentration of a pollutant and its fate is complex. At reasonably high concentrations (>100 µg/l) utilization of a pollutant can provide an ecological advantage, resulting in an increase in the numbers of microbes that metabolize the organic pollutant. At concentrations less than 10 µg/l, use of the pollutant usually cloes not provide enough of an advantage to lead to enrichment of active organisms. At concentrations greater than 1,000-10,000 µg/l, metabolism of the pollutant can entirely deplete oxygen or other metabolic requirements in

As a result, compounds that usually are considered degradable may not be transformed by the subsurface microorganisms i the compound is present at low concentra-tions. Similarly, compounds present at high concentration may be only partially degraded when oxygen is entirely depleted and can only be degraded further after dispersion or other physical processes mix the contaminated water with oxygenated water.

Table 2 presents the authors' opinious concerning the prospects for biotransformation of several important classes of organic pollut-ants in groundwater. These predictions are based on a cautious extrapolation from the behavior of these compounds in other natural systems and on our admittedly limited experience with their behavior in the subsurface environment. The research effort in this area is expanding rapidly. As our knowledge grows, microbiology should become a useful mplement to the earth sciences in our search for a better understanding of the behavior of organic contaminants in the subsurface environment.

Acknowledgments

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References

Bouwer, E. J., B. E. Rittmann, and P. L. McCarty, Anaerobic degradation of halo-genated 1- and 2-carbon organic com-pounds, Environ. Sci. Tech. 15, 596-599, 1981.

Danielpol, D. L., The distribution of the fauna in the interstital habitats of riverine sediments of the Danube and Priesting (Austria), Int. J. Speleol. 8, 23-51, 1976. Ehrlich, G. G., D. F. Goerlitz, E. M. Godsy,

and M. F. Hult, Degradation of phenolic contaminants in ground water by Amaero-bic bacteria: St. Louis Park, Minnesota, Ground Water, 20, 703-710, 1982. Ghiorse, W. C., and D. L. Balkwill, Enumeration and morphological characterization of bacteria indigenous to subsurface environ-ments, Dev. Ind. Microbiol., 24, in press,

Parsons, F., Transformation of chlorinated organic solvents in ground water environments in South Florida, paper to be presented at the ACS Environmental Chemis try Symposium on Organic Contaminant Behavior in the Subsurface Environment, American Chemical Society, Washington,

D.C., Aug. 28 to Sept. 2, 1983. Pedros-Alio, C., and T. D. Brock, Assessing biomass and production of bacteria in cutrophic Lake Mendora, Wisconsin, Appl. Environ, Microbiol., 14, 203-218, 1982. Waksman, S. A., Bacterial numbers in soil, at different depths, and in different seasons

of the year, Sail Sci., 1, 363-380, 1916 White, D. C., G. A. Smith, M. J. Gehron, J. H. Parker, R. H. Findlay, R. F. Martz, and H. L. Fredrickson. The ground water aquifer microbiota: Biomass, conuminity structure, and mutitional status, Dev. Ind. Micro-

biol., 21, in press, 1983.
Wilson, J. L. J. F. McNaldy, B. H. Wilson, and M. J. Noonan, Biotransformation of selected organic pollutants in ground water, Dev. Ind. Microbiol., 24, in press, 1983a. Wilson, J. T., J. F. McNabb, D. L. Balkwill, and W. C. Ghiorse, Enumeration and characterization of bacteria undigenous to a shallow water-table aquifer. Ground Water. 21, 134-142, 1983b.

John T. Wilson is a soil microbiologist and microbi-al ecologist who has been actively involved in research dealing with biodegradation of organic contaminants in groundwater since receiving his Ph.D. from Cornell University in 1978. He is currently n microbiologist with the U.S. Environmental Protection Agency's Ground Water Research Branch at the Robert S. Kerr Environ-

mental Research Laboratory in Ada, Oklahoma, where his research is concentrated on developing a kinetic description of the biotransformation of or-James F. McNabb has

been a microbiologist with the Ground Water Research Branch of U.S. EPA's Robert S. Kerr Environmental Research Laboratory in Ada, Oklahoma, since the late 1960's. He has degrees from Texas Technological Universit and the University of Ohla homa and received in 1978 a Fulbrigh grant to conduct groundwater research in New Zealand. His research interests involve many aspects of groundwater microbiology including the development of methods for the study of subsurface microbial activity.



our or more rings *Possible, probably incomplete. ^{†Probable, at high concentration.}

lews

Borehole Sensor Records Quake

A permanent, self-contained borehole seismometer placed at 44°N, 160°E in the northwest Pacific on September 11, 1982, recorded the May 26 Japan quake while being serviced by the R/V Kana Keoki. The signal was recorded digitally (100 samples per second) and is unclipped. Data are well above noise level from 0.03 Hz to over 40 Hz, a frequency span of more than 10 octaves, on all three orthogonal seismic components (4.5 Hz geophones). The 30 sec signals are shear and surface waves recorded 84 dB below the peak

response of the geophones.

The instrument, placed by Hawaii Institute of Geophysics (FHG) scientists working from the D/V Glomar Challenger (DSDP Leg 88). also contains temperature and tilt sensors. The tilt sensors also recorded the quake. The seismometer is 20 m into basalt at the bottom of a 380 m hole in 5467 m of water. The noise levels are very low (6.4 nm²/Hz at 1 Hz, 10^{-5} nm²/Hz at GHz, and 6×10^{-7} nm²/Hz at 20 Hz), making it one of the quictest short-

period seismic stations in the world. While servicing the system, the HIG scientists recovered 64 days of continuous seismic data recorded between September 13 and November 16, 1982. Earthquakes were re-

corded about once per hour during that peri od. A second tape package will record the borehole data between May 26 and July 20,

Fred Duennebier, project scientist for the ocean sub-bottom seismometer, notes that the R/V Kana Keoki was extraordinarily lucky to be on site on the day of a major earthquake (which occurs only about once per year in the North Pacific). Data recording had begun only 8 hours before the quake hit. The in-strument was designed with funds from the National Science Foundation and is now funded by the Office of Naval Research.

This news item was contributed by Frederick K Duennebier, who is with the Haunii Institute of Geophysics, University of Howaii at Manoa, Honolulu. HI 96822.

EDITOR'S NOTE: The June 7, 1983, Eas incorrectly reported that the subsen seismic station placed earlier this year by the Naval Ocean Research and Development Activity's Marine Seismic System (MSS) office was the first of its kind ("First Subsea Seismic Station," p. 408). The first subsea seismic station was the Hawaii Institute of Geophysics ocean sub-bottom seismometer, which was first placed in 1979 off the coast of Mexico and was successfully placed two other times before the deployment of the MSS instrument.

The two fields within EEMS granting the

physics and oceanography; the two fields con-

ferring the fewest were geomorphology and glacial geology and atmospheric physics and

chemistry (see Table 2). Of the 582 EEMS

doctorates, 56 went to women, according to

NSF's special report Science and Engineering

torates were U.S. citizens, 17% (100) were

non-U.S. students, and 11 students did not

21 were from Europe, 17 from Africa, 11 from East Asia, 10 from West Asia, 9 from

Australasia, 7 from Canada, 6 from South

TABLE 2. Earth, Environmental, and

Marine Science Doctorates Awarded

Field of Doctorate 1980 Total Men Women

Source: National Science Foundation

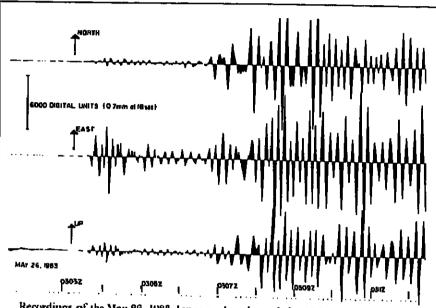
Applied geol. Aunospheric

21 21 27 26

specify citizenship. Of the non-U.S. students,

Roughly 80% (471) of the 582 EEMS doc-

most Ph.D.'s in 1981 were solid earth geo-



Recordings of the May 26, 1983, Japan carthquake made by 4.5 Hz geophones located in a hole under the Pacific ocean at 43°55′N, 155°48′E, about 16° from the epicenter. The seismograms were made from filtered digital data band-passed from 0.1Hz to 0.016 Hz.

Earth Science Ph.D.'s Down 7.3%

If the health of an academic discipline can be measured by the number of doctorates awarded, then there is good news for science and engineering: The total number of Ph.D.'s awarded in 1981 by universities in the United States rose 2.5% (to 17,623) from 1980. Not such good news for the earth sciences, though: The number of doctorates awarded in 1981 in the earth, environmental, and marine sciences (EEMS) dropped 7.3% (to 582), the sharpest decline in all science and engineering categories (see Table 1) according to a special report by the National Science Foundation (NSF).

The number of EEMS doctorates dropped in 1981 to the levels of the early 1970's (in 1972, 604 EEMS Ph.D.'s were awarded). NSF says preliminary clata show that the number of science and engineering doctorates granted in 1982 is virtually the same as for 1981; into subject areas, however.

TABLE I. Doc Women in	torates Av U.S., [9	varded to 80 and 19	Men and 081	Atmospheric phys. & chem.	19	15	14	
Category	1980	1981	Change,	Atmospheric sci., other Earth sci., general	51 48	31	30	
			.т	Earth sci., other	21	46	42	
Earth, environ.,	628	582	~7.3	Environ. sci., gen-		16	14	
& marine sci.				eral	. 15	30	27	
Physical sci.	2,521	0 666		Environ. sci., other	25	24	lń	
(Phys. & as-		2,626	+4.2	Geochem.	51.	48	43	
(ron.)	(983)	(1,015)	(+3.3)	Geomorphology & glacial geol.	15	13	ii	
(Chem.)	(1,538)	(1,611)	(+4.7)	Geophys., solid	71	72	~~	
Engineering	2.479	2,528	+2,0	earth	11.	12	67	٠,
Mathematical sci.	962	960	-0.2	Hydrol. & water	02			
Life sci.	4,716	4,783	+1.4	research	27	21	20.	:
(Biol. sci.)	(3.804)	(3,801)	(-0.1)	Marine sci.	B			٠.
(Agricul. sci.)	(912)	(982)	(+7.7)		25	30	28	!
Social sci.	2,795	2,787		Mineral., petrol.	47	30	25	'
Psychology	3.098		-0.3	Oceanogr.	85	70	, 63	•
Nonsci. & non-		3,357	+8.4	Paleontol.	21	ં (ં9	18	
eng.	13,817	13,698	-0.9	Stratigr., sedimentiol.	· 40'	. 42	35	. !
Total, all fickls	31,016	31,319	+1.0	Structural geol.	, 20	27	26.	_'
Source: Nations	al Science	Foundst	idal par	Total	628	582	526	5(

Volcanic Sulfur

Forum

Although I may be overly demanding in expecting a member of the Eos staff to be familiar with recent articles in AGU journals, I am moved to make a mild protest concerning attribution in the "Volcanic Sulfur Dynamics" news item by Mario E. Godinez (Eas, June 14, 1983, p. 411).

Since the news story stated that an important result of the RAVE experiment was to estimate the SO2 flux from Mount St. Helens on just one day, I must point out that both my research group and USGS scientists have monitored the emissions from Mount St. Helens and estimated SO₂ (and other) fluxes over extended periods of time. Our results, which were based on in situ airborne measurements carried out over a period of a year, include estimates of the flux rates of SO₂, H₂S, H₂O, sulfates, halides, and various other particles, prior to, during, and after the explosive eruption of Mount St. Helens on May 18, 1980 [Hubbs et al., 1983]. The USGS measurements, which are made remotely through use of an airborne correlation spectrometer, also commenced in 1980 and have provided data several times a week since that time [Casadevall et al., 1981]. We have also estimated the fluxes of various materials (including SO2) from eight other volcanos [Radke et al., 1976; Stith et al., 1978; Radhe, 1982].

In summarizing (correctly) the conten-tion of Berresheim and Jaeschke [1983], the news story states: "Emissions of sulfur during noneruptive phases, previously neglected by researchers, are the main source of the volcanic sulfur in the atmosphere" (italics added). We stated in 1978: "A large fraction of both the gaseous sulfur and small particles produced by the 1976 eruption of Saint Augustine were emitted during the milder eruptive periods (intraeruptive and post-eruptive). As far as tropospheric effects are concerned, perhaps more attention should be paid to these types of emissions, which inject particles and gas into the atmosphere over long periods of time, than to the more sporadic, extremely violent volcanic paroxysms, which generally attract most interest" [Stith et al., 1978]. Concerning Mount St. Helens we wrote: "the long-term posteruptive emissions (of sulfur gases) dominated the annual inputs" [Hobbs et al., 1982]. Nihil sub sole novi.

Finally, the news story's statement that "effects of sulturic acid [from volcank eruptions] are minimal in the troposphere" should not go unchallenged. Due-ing our airborne studies of the effluent from Mount St. Helens we collected water samples that had pH's less than unity [Hobbs et al., 1982]. Clearly, the large quantities of sulfur (and other acidic) substances, emitted by some volcanos have the potential to cause significant local and regional impacts in the troposphere, including acid rain. In the case of the Antarctic, it has been estimated that the sulfur emissions from Mount Erebus could contribute as much as ~30% to the total atmospheric sulfate budget of that continent [Radke, 1982].

References

Berresheim, H., and W. Jaeschke, The contribution of volcanos to the global amospheric sulfur budget, J. Geophys. Res., 88, 3732-3740, 1983.

Casadevall, T. J., D. A. Johnston, D. M. Harris, W. I. Rose, Jr., L. L. Malinconico, R. E. Stoiber, T. J. Bornhorst, S. N. Williams, L. Woodruff, and J. M. Thompson, SO2 emission rates at Mount St. Helens from March 29 through December 1980, in The 1980 Eruptions of Mount St. Helens, Washington, U.S. Geol. Surv. Prof. Pap. 1250, edited by P. W. Lipman and D. R. Mullineaux,

Hobbs, P. V., J. P. Tuell, D. A. Hegg, I. F. Radke, and M. W. Eligroth, Particles and gases in the emission from the 1980-81 volcanic cruptions of Mt. St. Helens, J. Geophys. Res., 87, 11062-11086, 1982.

Radke, L. F., Sulfur and sulfate from Mt. Erebus, Nature, 299, 710-712, 1982. Radke, L. F., P. V. Hobbs, and J. L. Stith Airborne measurements of gases and aerosols from volcanic vents on Mt. Baker, Geophys. Rev. Lett., 3, 93-96.

Smith, J. L., P. V. Hobbs, and L. F. Radke, Airborne particle and gas measurements in the emissions from six volcanos, J. Geophys. Res., 83, 4009-4017,

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America, 5 from Mexico and Central America, and I from the region classified as "Culxi and the islands"; the remaining 13 non-U.S. students did not specify their homeland.

Women receiving doctorates in the earth, environmental, and marine sciences in 1981 tended to be younger than their male classmates. And, while women receiving EEMS doctorates in 1981 were younger than those women receiving doctorates in 1980, men receiving doctorates in 1981 tended to be older than those receiving the degree the previous year. The median age of EEMS women doctorates in 1981 was 29.94 years, compared to 30.50 years in 1980. The median age of EEMS men doctorates in 1981 was 31.06

years, compared to 30.87 years in 1980. For the EEMS doctorate class of 1981, less time elapsed between the baccalaureate degree and the Ph.D. for women than for men, eccording to NSF's report. For women receiving EEMS Ph.D.'s in 1981, the median time

between baccalaureate and advanced degree was 7.63 years; for men it was 8.36 years in 1980, however, the discrepancy was smaller the median time was 8.00 years for women and 8.06 years for men. Those receiving do torates in EEMS in 1981 took longer (media average was 8.27 years) to complete their de grees than any class had in at least 22 years. In addition, this median average is longer than the median average of 7.63 years between baccalaurente and Ph.D. for all science and engineering doctorates. The shones me dian time between baccalaureate and Ph.D. among all science and engineering fields was for the physical sciences (6.38 years), especial ly chemistry (5.99) years); the longest media time was for the social sciences (9.30 years) The median average between the two degrees was longest (12.22 years) for all nonscience and nonengineering doctorates. This figure includes doctorates where no field specialist tion could be ascertained.

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NSF's special report also analyzes the distribution of science and engineering doctorates renferred at the top 100 doctorate-producing institutions in the U.S. Those universities that granted more than 200 EEMS doctorates beween 1960 and 1981 inclusive are The Pennwhania State Univ.; Stanford Univ.; Massachuseus Institute of Technology; the Univ. of Wisconsin-Madison; the Univ. of Washingion; Univ. of California (UC), Los Angeles; Columbia Univ.; the Univ. of Michigan; UC, Berkeley: UC, San Diego; the Univ. of Arizona; Texas A&M Univ.; the Univ. of Illinois; largard Univ.; Oregon State University; and Ohio State University. Though also in this op 100 category, Brandeis, American, Teme and Vanderbilt universities granted no EEMS doctorates 1960-1981, according to

IUGG Corrections

A paper entitled Geochemical Evolution of the Crust and Mantle by Donald J. DePaolo sas inadvertently omitted from the table of onents published with the IUGG Overview of Volcanology, Geochemistry, and Petrology, The overview appeared in Ens., August 2, 1983, p. 481.

A paper entitled Accreted Terranes by Amos Nur that was submitted to the Tectonophysics section of the IUGG report was omitted from the July issue of Reviews of Geo-physics and Space Physics. The paper will appear in the November issue of RGSP as an ddendum to the IUGG report. Members of the Tectonophysics section, who received the Teconophysics report, will receive a reprint of this article.

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Cover. Electron micrographs of microbial cells released from subsurface samples. (a) Thin section of cell released by the plending-centrifugation method. Note Gram-negative wall structure and presence of fibrous polysaccharide slime material ial around cell. (b) Thin section of cell released by the blending-centrifugation method. Note Gram-positive cell wall and presence of cross wall (division septum) within cell (CW). (c) Negative stain of cell released by the flotation method. Light areas within cell are probably PHB (poly-Bhydroxybutyrate) granules. (d) Negative stain of cell released by the flotation method Marcolland od. Note Gram-negative wall structure and that cell appears to be dividing. (Phoo submitted by John T. Wilson and James f. McNabb; reprinted by permission of rights reserved.) (See p. 505 for article.)

Eos To List Ph.D. Data

Eos plans to list, regularly, the titles and authors of recently accepted doctoral dissertations in the disciplines of geophysics The listings will begin with degrees award

ed since January 1, 1983.

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(3) Name of department and institution granting the degree (4) Month and year degree was awarde

If possible, include the address and teleshone number of the degree recipient and information on how a copy of the disertation or its abstract may be obtained. Send the information to Eas, 2000 Florida Avenue, N.W., Washington, DC 20009.

Recruiting **Astronauts**

The National Aeronautics and Space Administration (NASA) is recruiting candidates for its 1-year training and evaluation pro-gram for space shuttle pilots and mission specialists. Applications will be accepted between October 1 and December 1, 1983; selections will be made by May 1984, and successful candidates will begin their training in July

Candidates for mission specialist must have a bachelor's degree from an accredited institution in engineering, in the biological or physical sciences, or in mathematics. The degree must be supplemented by at least 3 years of related professional experience. An advanced degree is desirable and may be substituted for all or part of the experience re-

Applicants for pilot positions must have a degree in the natural sciences and at least 1,000 hours of pilot-in-command time in high performance jet aircraft.

As part of its affirmative action program. NASA is encouraging applications from qual-ified women and minority candidates. Gur-rent regulations require that U.S. citizens be given preference for all apppointments to the

Requests for an application package should be addressed to Astronaut Candidate Program, Mail Code AHX, NASA Johnson Space Center, Houston, TX 77058.

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Hugo B. Fischer, 48. A member of the Hydrology section, he joined AGU in 1967.

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Books

Physics of the Jovian Magnetosphere

A. J. Dessler (Ed.), Cambridge Planet. Sci. Ser., Cambridge University Press, New York, xv + 544 pp., 1983, \$29.50.

Reviewed by Andrew F. Cheng

Physics of the Jovian Magnetosphere is a com-prehensive reference devoted to the latest advances in Jovian magnetosphere physics. oyager spacecraft have led to an explosive development in the subject, with unprecedented coverage in both the popular press and the technical literature. Since 1974 no less than four special issues of Science, three special issues of the Journal of Geophysical Research, and special issues of Nature, Icarus, and Geophysical Research Letters have been devoted

Why all the fuss? The Jovian magnetosphere is simply one of the most exotic and nteresting objects in the sky.

1. Jupiter's magnetosphere is the most powerful planetary radio source in the solar ystem, with a spectrum ranging from ~10 kHz, too low to propagate even in the solar wind, to above a GHz.

2. The radio emission at 10-1000 m wave lengths is pulsed at Jupiter's rotation period. The decametric radio emission is also modulated at to's orbital period. Similar intense, periodic radio emissions are characteristic of the earth and the radio pulsars.

3. An ultraviolet aurora on Jupiter appears to be powered ultimately by the rotation of Jupiter rather than by solar wind interaction as at earth.

4. A sulfur and oxygen ion plasma, with density and temperature similar to the Orion Nebula, is found near to's orbit. The source of this sulfur and oxygen appears to be lo's volcanos. Sulfur and oxygen ions dominate the mass and charge density of the magneto-

5. Optical and ultraviolet emission lines are observed. Solar resonance lines are detected from sodium and potassium atoms, and colli sionally excited forbidden and allowed transitions are observed from sulfur and oxygen

6. A hot heavy ion plasma is found in the onter magnetosphere, composed mainly of sultur and oxygen ions with typical energies

7. Jupiter's magnetosphere is the dominant source of less than ~40 MeV electrons in the solar system. It is also known to be a source of soft X rays ~ 0.1-4 keV, energetic neutral particles ~40 keV, and energetic Hs or Hs* iolecules above an MeV.

Thus, the Jovian magnetosphere is not only a uniquely interesting object in its own right but, in addition, it has significant implications for many astrophysical problems, such as physics of radio pulsars, HII regions and planetary nebulae, and energetic particle acceleration. No less significant are the implications for problems closer to home, such as the aurora, physics of plasma transport and heating in planetary magnetospheres, and so-

ar-terrestrial interactions. Many workers in astrophysics, space physics, and geophysics are undoubtedly aware that exciting discoveries have been made about Jupiter but have been waiting for the early results to be collected and digested. These people need wait no longer. Here, in the book Physics of the Jovian Magnetosphere is a comprehensive, up-to-date, and authorita-tive treatment of the latest advances in the field, up to 1982.

The book consists of 12 chapters by 16 au thors, with a uniform notation and termine gy. The chapters can be read in any order, and each chapter is essentially self-contained between chapters, although there is minor overlap with the companion volume Satellites

of Jupiter.

The first eight chapters give a complete and uniformly excellent review of the observations. These chapters alone are worth the price of the book. The remaining four chapters are theoretical and vary widely in scope, depth, and detail. A unique bonus is the appendix on Jovian coordinate systems, which gives a useful explanation of the many Jovian latitude and longitude conventions. The level of the book, particularly in the observational chapters, is suitable for graduate students. and research workers outside the field. Some of the material in the theoretical chapters will be fully appreciated only by experts in plas-

It might have been helpful to provide an introductory overview chapter, which would have given a survey of the main phenomeno ogy, assessed the current status of the field, indicated some directions for future development, and finally discussed implications for other fields in astrophysics and space physics. The individual chapters in the book do provide summary and discussion sections, which discuss some of these topics, but within the context of the separate subfields.

In short, this book is a unique and invaluable resource, which should be considered an essential acquisition for libraries and individuals interested in space plasmas and plasma astrophysics. It is also highly recommended for astrophysicists and space physicists in gen-

Andrew F. Cheng is with the Applied Physics Laboratory, The Johns Hopkins University, Laurel, MD 20707.

Satellites of Iupiter

D. Morrison (Ed.), University of Arizona Press, Tucson, Arizona, x + 972 pp., 1982,

Reviewed by D. J. Stevenson

Future historians of science will look back on the arrivals of the Voyager spacecraft at the Jupiter system in 1979 as very significant events, primarily because of the remarkable diversity of new phenomena discovered on the Galilean statellites. In a short time period there was almost a doubling of the number of solid "planetary" bodies for which substantial scientific analysis is possible. Scientists were introduced to the novelties of tidally heated bodies and of ice tectonics. From a more fundamental point of view, there is much to be learned about the origin and evolution of planets and their environments from analysis of the satellite systems. Any doubts about the importance of studying planetary satellites must have been dispelled by the Voyager mis-

A meeting was held in Hawaii, May 1980, primarily to present and to discuss the results of the Voyager observations of the Jovian satellites. Arising from the meeting came this new book, another in the excellent Space Science Series of volumes published by the Unviersity of Arizona Press, Edited by David Morrison with the assistance of Mildred Sha pley Mauhews, Satellites of Jupiter involves 47 allaborating authors, 24 chapters, and is for the most part impressively comprehensive and authoritative. Perhaps inevitably it is also probably the least successful in this series of volumes. Even this is a mild criticism because of the high standards achieved and maintained by these books.

The problem lies in the nature of the subject matter and the circumstances in which this book was produced. Whereas most previous volumes (e.g., Planetary Satellites, Asteroids) consisted primarily of thoughtful, broad, and integrated reviews of well-established subject matter, authors in Satellites of Jupiter were confronted with the task of digesting an enormous data set and presenting overviews of new science in a short period of time. Most of the chapters were finished less than 18

Books (cont. on p. 508)

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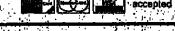
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ues, with a strong emphasis on all elements of ocean prediction. Two or more tenure-

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ing will most likely be done at the assistant or associate professor level. (Further post-

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Candidates with theoretical or experimental expertise are of interest. The Depart-

and research faculty, and a technical and clerical staff of 25. There are in excess of

80 graduate students, largely shared with the Meteorology Department, which is near-

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ly equal in size and which also has interests in air-sea interaction and ocean model-

ing region of the ocean, free access to an IBM 3033, and proximity to the Fleet Nu-

merical Oceanography Center and the Naval Environmental Prediction Research Fa-

clity. Links exist to NORDA, the Naval Oceanographic Office, other Navy labs, and

NCAA activities, as well as other academic institutions. Altogether, there are over 100

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Books (cont. from p. 507)

months after the Voyager encounters; a late chapter or two greatly delayed publication until 1982. As a consequence of the limited time and the novelty of the science, some of the chapters read more like journal papers than review articles. This reviewer also suspects that many of the theoretical interpeta-tions presented will be (or are being) superseded. In fact, most of the fundamental questions posed by the Voyager results remain unanswered. For example, the heat flow of lo is not quantitatively understood (although the tidal heating proposed by Peale et al. is not seriously in doubt), the nature of Europa's surface and outer regions remains enigmatic, no entirely satisfactory explanation yet exists for the remarkable surficial dissimilarity of Ganymede and Callisto, all aspects of the satellite histories (orbital evolution, cratering, internal structure, surface modification, atmospheric) remain controversial, the geochemistry of lo's volcanism is puzzling, and the dynamics of the Io plasma torus remain unclear. Controversy and uncertainty are the lifebood of science, but the level of ignorance may not be apparent to the reader confronted with 972 pages of information overload.

This book is nevertheless indispensible to the planetary scientist and invaluable to the graduate student or researcher entering (or contemplating) this area. Around 40% of the text deals with fo, an appropriate fraction because of the diversity of phenomena related to it. The other Galilean satellites also receive

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extensive coverage, and separate chapters are clevoted to the rings of Saturn, Amalthea, the outer satellites, and the Jo torus. However, most of the chapters deal with physical phenomena rather than with specific bodies.

Notable chapters include S. W. Kieffer's very thorough (although possibly too deailed) effort on the dynamics and thermody namics of volcanic eruptions; no comparable effort exists anywhere else. The effort by Shoemaker and Wolfe, on cratering time scales, is also a remarkable if somewhat controversial synthesis of existing data and theory. Ostro's chapter on the radar observation of the icy satellites is interesting becuase it of-fers a tantalizing glimpse of the nature of the

uppermost few meters, potentially very im-portant for understanding the compositional and tectonic evolutions of these bodies. The chapter on atmospheres by Kumar and Hunten is succinct yet thorough, and the geologi-cal chapters (Ganymede by Shoemaker et al., Europa by Lucchitta and Soderblom, Io by Shaber) are uniformly well written and good at the descriptive level (but occasionally faltering at the interpretive level). Typical of the University of Arizona Space

Science Series, this text is well produced, with a small (but finite) density of typographical er-rors and a substantial but understandable price in view of the bulk. It could have benefited from stronger editorial control to reduce length, and it also suffers from a small but significant number of poorly reproduced Voyager images or maps (even allowing for the limitations of non-glossy paper). It will re-

main a very useful text for many years, if only because of the infrequency of deep

D. I. Stevenson is with the Division of Geological and Planetary Sciences, California Institute of Technology, Pasadena, CA 91125.

Physique Moleculaire: Physique de l'Atmosphere

C. Camy-Peyret (Ed.), Editions du Centre National de la Recherche Scientifique, Paris, 502

Reviewed by Marcel Ackerman

Physique Moleculaire: Physique de l'Atmosphere is a collection of lectures presented at a winter school on the "Application of Molecular Physics to the Atmosphere and to the Envi-ronment," organized from December 1-10, 1983, in Montfoulon (Normandy) under the auspices of various French governmental agencies including the National Center for Scientific Research (CNRS), the Center for Nuclear Studies, and the National Center for Space Studies (CNES). This initiative is part of a policy which developed a few years ago in France and is intended to promote interdisciplinary activities in order to foster interdisciplinary research.

Since the early 1970s, several serious questions have been put to the scientific commu-

nity concerning the possible effects of man's activities on the atmosphere and the likely impact these effects have on the climate. The goal of these lectures was to encourage French scientific communities active in aeroe omy, chemical kinetics, meterology, and spetroscopy to work together on those quenous of upper atmosphere-climate relationship since they offer a typical interdisciplinary character. Most of the 12 lectures are in French, except for two that are in English and can be devided into two groups into-ductions of the structure of the atmosphere the photochemistry and spectroscopy of a mospheric gases, the radiative transfer and the dynamic modeling of transport phenom na, and photochemistry in the atmosphere and more specialized treatments of remote sensing and in sim techniques used to gather data on the atmosphere from the ground a well as from airborne and space platforus in passive and active modes.

Most of the papers are clearly presented and are well documented with general as well as specific references on the various topics. There are, however, some inhomogeneous among the presentations and redundances the presented material. The book will be use ful not necessarily only to fluent French readers, since the book is essentially technical, and it may be a useful introduction to the many very specialized reports and proceedings that have appeared in the last 10 years.

Marcel Acherman is with the Belgium Space

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D. A. Gurnett **Department of Physics and Astronomy** The University of Iowa Iowa City, Iowa 52242 Telephone 319/353-3527.

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PHYSICAL OCEANOGRAPHER/University of

Supervisory Oceanographer/National Ocean Service. Physical Oceanographer, National Ocean Service. A supervisory oceanographer position is immediately available as Chief. Data Processing and Analysis Unit, Circulation Section, Office of Oceanography and Marine Service. The incumbent will supervise seven oceanographers and one physical science technician. Duties include planning circulation surveys conducted by NOAA vessels, processing data collected, and conducting tidal and nonticial analyses. Data collected include current meter, CTD, and meteorological data acquired from the Nation's estuaries and inner continental shelves. Circulation Survey Reports are published for major surveys. Research Associate/Petrography-Petrology. To join a research effort aimed at understanding the condensation history of the solar system by miners

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Bidrogeologist, Hydrologist, or Water Resources Planer. The Kansas Geological Survey, a division of The University of Kansas, solicits applications for abdrogeologist, hydrologist, or water resources planer. Fernanent, full-time position subject to ansat review. Solary Range: \$20,000–\$30,000 per sea, depending on qualifications. Required qualifications stater's degree in hydrogeology, hydrologo-go orelated water resources field. Course work in hereikal hydrologic modeling and capability to apply these models to different hydrologic and water planning problems to particular areas in Kansas.

above fields, and 2-3 years of research experience in water resources related studies.

Freedom to conduct research within the framework of the KGS Geohydrology Section's programs and support of a university environment. Opportunity for graduate study or teaching; and fully funded research opportunities in excellent research facilities.

Contact Personnel Manager, Kansas Geological Survey, 1930 Constant Avenue, Campus Wesi, The University of Kansas, Lawrence, Kansas 66044 (Ph. 913/864-3965) for full position description, or to apply, send resume, college transcripts, list of published research, and three letters of reference. Priority will be given to applications received by October 31, 1983. Applications will be accepted and reviewed every thirty days thereafter until the position is filled. AN EQUAL OPPORTUNITY/AFFIRMATIVE ACTION EMPLOYER.

Iowa State University of Science and Technology, Department of Earth Sciences. Applications are invited for a tenure track faculty position in Meteorology. Rank is at the assistant or associate professor level, dependent upon qualifications. The successful applicant will be expected to develop a strong research and graduate student program and will teach undergraduate and graduate courses for meteorology majors.

The position is for a person with proven expertise within the general area of dynamic meteorology. Teaching will involve an undergraduate course in synoptic meteorology, in addition to courses related to the field of expertise. Completion of the Ph.D. prior to appointment is strongly preferred. In addition, research ability shown by other publications and/or postdoctural experience will be an advanand/or postdoctoral experience will be an advan

tage.

Jova State offers degrees in meteorology through the Ph.D. The program includes about 60 undergraduate majors; the graduate/research program is strong and emphasizes theoretical, dynamic studies. Close relationships are established with the facilities and personnel of major national laboratories. New campus facilities for ineteorology are currently under construction.

der construction.

The appointment is expected to begin no later than September, 1984; an appointment during the current academic year may be possible. Application deadline is November 1, 1983; later applications will be accepted if the position is not fulled. For application information please write to:

Dr. Bert E. Nordlie

Department of Earth Sciences

Lowa State University

253 Science 1

Annes, Lowa 50011.

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firmative action employer.

Research Scientist/Space Plasma Physics, University of Iowa. A research position is available in the Department of Physics and Astronomy. The University of Iowa, for theoretical and interpretative studies of waves in space plasmas. Specific emphasis on theoretical investigations of wave-particle interaction of the production of the pr on theoretical investigations of wave-particle interac-tions in planetary magnetospheres and in the solar wind. These investigations are to support the inter-pretation of data being obtained from space rath projects such as Dynamics Explorer. International Sim Earth Explorer and Voyager. The applicant must have a Ph.D. with good quality attents in plas-ma physics theory and should have some experience in the interpretation of space plasma physics data. Send a resume and the names of three references familiar with the applicant's work to: D.A. Gurnett, Department of Physics and Astronomy. The Univer-sity of Lowa, Jowa City, Jowa 52242, telephone 319, 353-3527.

The University of Lowa is an allo mative action?

The University of Iowa is an affirmative action/

University of California/Assistant Researcher.
Stripps Institution of Occanography invites applications for the position of Postgraduate Researcher through Assistant Researcher. Appointment as Assistant Researcher requires a publication record. The position is in the upper occur physics group of the Marine Physical Laboratory. Active research areas include air sea interaction, internal wave and mixed layer studies, as well as doppler acoustic sensor design. Candidates should have a Ph.D. in Occanography, Physics or Engineering as well as sor design. Candidates should have a Ph.D. in Occampraphy, Physics or Engineering as well as experience and a desire to participate in field re-search. Salary range: \$15,936 to \$26,800. Send cur-riculum vitae and names of references to Professor Robert Pinkel, Marine Physical Laboratory, Scripps Institution of Oceanography, UCSD, San Diego, CA 92152. Closing date: August \$1, 1985 The University of California, San Diego is an Equal Opportunity Affirmative Action Employer.

ers in these positions will be expected to supply a significant portion or all of their salaries through their grants and contracts. Aplicants should submit a curviculum vita, list of publications, and the names of three references by November 1, 1983, to 1, 1. Wilkening, Director, Tunar and Planetary Laboratory, University of Ari-cory, Turson, AZ 57291. zona, Tueson, AZ 85721.

The University of Arizona is an Equal Opportuni

tv. Afhrmanye Action Employer

through the addition of three terms e-flack laroffly positions. Appointments are anticipated at the axist-am professor level, although higher ranks may be possible, beginning in August of 1984. Candidates will be expected to have completed requirements to the Ph.D. degree by that time. Faculty members are required to provide quality instruction at both undergraduate and graduate levels, and conduct research leading to scholarly publications. Successful candidates will be chosen from the following specialities: DIRECTOR OF SCIENCE National Undersea Re-search Program/University of North Carolina at Wilmington. The National Undersea Research Program at the University of North Carolina at Wil-mington is a federally funded moltostate mature re-search program sponsories by the National Oceanic and Atmospheric Administration (NOAA). The Program is seeking qualified applicants for the posi-tion of Director of Science. The Director is respon-sible for developing the overall program objectives and strategies, as well as for eliciting, reviewing and coordinating marine research proposals. The Direc-tor of Science reports administratively to the Pro-gram Director. Academic rank and salary shall be commensurate with experience and qualifications. Starting date is October 1, 1983. Applicants must have a Ph.D. in a marine orient-ed discipline and an established research will publi-Sold (Farth to ophysics)
Hydrogeology
Analytical Structural Geology
Clastic Sedmentology
Applicants should send restance, transcripts, and
names and addresses of three references to:
Tom Freeman, Chairman
Department of Geology
University of Missouri
Columbia, MO 65211.

Research Positions/Lunar and Planetary Laboratory. The Lunar and Planetary Laboratory at the University of Arizona has research positions open for Research Scientists. Researchers at the Laboratory have access to the University's observatories, a wide range of astronomical instrumentation, a complete collection of planetary images, computers and laboratory facilities. The research ranks in the Laboratory, namely Assistant Research Scientist, Associate Research Scientist, and Research Scientist parallel the tenure track ranks of Assistant, Associate and Full Professor. Salary levels are commensurate with equivalent tenure-track ranks. These are not tenurable and not state-funded positions. Research-Starting date is October 1, 1983.

Applicates must have a Ph.D. in a marine oriented discipline and an established research and publication record. A letter of application, a complete resume and at least three current letters of recommendation should be submitted, no later than September 1, 1983, to: Search Committee-Director of Science, Office of the Vice Chancellor for Academic Affairs, University of North Carolina at Wilmington, 601 South College Road, Willington, North Carlina 28403–3297.

An Equal Opportunity/Affarmative Action Em-

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Eos Delivers.

<u>Meetinas</u>

Announcements

Deep Fault Zone Drilling

Papers are invited for a special session on the kientific and operational aspects of deep dilling in active fault zones that will be held during the 1983 AGU Fall Meeting in San Francisco, December 5–10. The National Academy of Sciences Continental Scientific Indian of Sciences Continental Scientific Drilling Committee supports the session as a forum for gauging the geology community's interest in deep drilling as a tool for advancing knowledge of earthquake mechanics.

A decade of march and a control faults, par-A decade of research on active faults, parcularly the San Andreas fault, has brought to light a number of issues that may be effi-dently addressed by coring into or near a stumically active.

simically active rupture zone. For instance, is a matter of long-standing dispute whether the San Andreas fault is in a state of low stress (<100-200 × 10° N m²) as suggested by the observed low heat flow or high stress (>1000 × 103 N m⁻⁸) as suggested by laboratory studies of rock friction; it is not known if ater at seismogenic depths is mobile or con-ined, plentiful or sparse; the correlation of fault Beometry and mineralogy/petrofabric with sesimic activity is limited to loose conjecture. mes. However, the cost of a single drillhole s much more than most geoscientific organi-tations can afford. Therefore, a goal of the range can attord. Therefore, a goat of the smon is to help generate a consensus on the importance of such drilling.

The contributions will complement a small in the contributions will complement a small in the contributions.

number of invited speakers who will address well-established aspects of deep drilling and review the outstanding scientific questions in fault zone properties. Serious contributions on matters such as drillhole location, drill core acquisition in and out of the fault zone per, and use of the hole for short- and long-term experiments in earthquake mechanics are welcome. Case histories in deep drilling and/or borehole experimentation pertinent to the fault problem would be particularly desirable. Abstracts in standard AGU format should be sent to Peter Leary or Tom Henyey, Department of Geological Sciences, University of Southern California, Los Ange-les, CA 90089-0741 (telephone: 213-743-8034 or 213-743-6123). In addition, send the original and two copies of the abstract by September 14 to AGU Fall Meeting, 2000 Florida Avenue, N.W., Washington, DC

South East Asian Survey Congress

Hong Kong will host the Second South East Asian Survey Congress, scheduled for December 5-9, 1983. The meeting will be divided into three basic categories; land, engineering, and hydrographic surveying; land economy, valuation, and property management; and quantity surveying and building surveying. In addition to the technical sesisions, tours to various locations in China are

planned.
For additional information, contact the

Conference The first Pacific Conference on Marine Technology (PACON 84) will be held April 24-27, 1984, in Honolidu, Hawali. This international and interdisciplinary meeting is designed to provide academicians, resource planners, policy analysts, entrepreneurs, and administrators with an opportunity to discuss the economic, legal, political, defense, and sociocultural dimensions of marine resource

Congress Secretariat, Second South East

Pacific Marine

Asian Survey Congress, 57 Wyndham Street, 1st Floor, Central, Hong Kong (Telex: 72500

HX). The registration deadline is September

pact of marine technology on the quality of life in this region.

Sessions are planned on ocean energy, marine tecreation, development financing, ocean mining, ocean science and engineering. marine transportation, offshore resource de-velopment, fisheries, trade, technology transfer, navigation and positioning, remote sens-ing, and tsunamt detection. Research and in-

development and management in the Pacific

Basin. Special attention will be paid to the im-

dustrial exhibits will be on display. Authors interested in presenting papers at the conference should submit abstracts of approximately 400 words to PACON 84; Center. for Engineering Research, University of Ha-

Meetings (coul. on p. 510.)

Every Tuesday. Every Week. "CTF Systems has found Eos to be an effective medium for introducing our innovations in magnetometry to the perchasical community." geophysical community." -Mark Dowding Marketing Manage CIF Systems Eos is read every week by 16,000 geo-physicists worldwide. The most convenient and economical way to reach these readers is to advertise in Eos. For low adventising rates and copy deadlines, please call. Robin E. Urtie 900,424-2488.

9 95 1300

Meetings (cont. from p. 509)

waii at Manoa, Honolulu, HI 96822 (telephone: 808-948-7338 or 808-948-7449). The deadline for abstracts is November 15, 1983. Accepted papers will be considered for publication in the conference proceedings.

The Hawaii Section of the Marine Technology Society, with the assistance of 12 other sponsors from government, education, and business, is organizing this meeting.

AWRA Conference

The American Water Resources Association will hold its 20th Annual Water Resources Conference in Washington, D. C., August 13-16, 1984. A symposium on Options for Reching Water Quality Goals will highlight the activities scheduled for August

Presentations at the conference will reflect three themes: (1) Institutional Aspects of Water Management will address such topics as state—federal relationships, establishing priorities for water resources investments, and the problems of decaying urban water infrastructures; (2) Water Management Technology will deal with analytical methods for analyzing the performance of water resources sys-tems and with innovative and novel approaches to water management; (3) Data, Research, and Assessment needs will deal with research needs to support improved water management, data needs for analyzing system performance, and future directions for asessing the nation's water resources.

The water-quality symposium will consist of two half-day sessions. No technical sessions on the main themes of the conference will be conducted on the day of the symposium. One section of the symposium will deal with sur-face water quality. Papers addressing this top-ic should focus on institutional and technical aspects of pollution control from point and nonpoint sources, monitoring for water quality, water quality-quantity relationships, and alternative and innovative technology for pollution abatement. The second section of the symposium will deal with groundwater quali-

NAME ON BADGE

ty. Papers on this topic may deal with the prevention and cleanup of contaminated unlerground aquifers, institutional and technical aspects of controlling groundwater politition, and groundwater and surface water in-

All abstracts must be submitted (three copies) by November 15, 1983. Abstracts for conference papers should be sent to Warren Viessman, Jr., Department of Environmental Engineering Sciences, University of Florida, A. P. Black Hall, Gainesville, FL 32611 (telephone: 904-392-0834) or Claire Welty, U.S. Environmental Protection Agency, WH-565B, 401 M Street, S.W., Washington, DC 20460 (telephone: 202-382-4806). Abstracts for symposium papers should be submitted to Theo-dore M. Schad, National Academy of Sciences, 2101 Constitution Avenue, N.W., Washington, DC 20418 (telephone: 202-334-

The general chairman of the conference and symposium is Arlene Dietz, U.S. Army Corps of Engineers, Institute for Water Resources, Casey Building, Fort Belvior, VA 22060 (telephone: 202-325-6768).

Hawaii Observatory Diamond Jubilee

The Diamond Jubilee of the Hawaiian Vol-cano Observatory is being planned for 1987 in Hawaii National Park. Founded in 1912 by Thomas Jaggar and operated by the U.S. Geological Survey (USGS) from 1924–1935 and since 1947, the observatory has pioneered some of the techniques now used at some 25 worldwide volcano observatories that monitor active and potentially active volcanoes.

The international scientific meeting that will mark the observatory's 75th anniversary will focus on volcano monitoring and on re-ducing volcanic risk. The formal meeting will be interspersed with field trips to volcanic sites on the island of Hawaii.

For more information, contact Robert W. Decker, Scientist in Charge, USGS, Hawaiian Volcano Observatory, Hawaii National Park,

FALL MEA by the Bay

AGU Fall Meeting: Housing and Registration

ancisco Dec.5.

The 1983 Fall Meeting of the American Geophysical Union will be held in San Francisco, California, December 5-10 at the Cathedral Hill Hotel and the Holiday Inn Golden Gateway Hotel. San Francisco is a dynamic, exciting city, known to the world for its spectacular scenery, fabulous restaurants, cosmopolitan life style, and gentle climate. It is a superb meeting location at any time of the

Registration

Everyone who attends the meeting must register. Preregistration (received by November 10) saves you time and money. The fee will be refunded to you if AGU receives written notice of cancelation by November 28 Registration rates are as follows:

Preregistration No. F Student member of NRM; applications of magnetic anisotropy to fabric analyses and tectonics; solving prob-Retired senior member \$32 Nonmember Student nonmember \$-11.50

oblems in a broad range of fields such as

geophysics, geology, planetary science, and biology. A wide variety of papers is encour-

aged Examples of topics to be addressed in-dude conventional applications of rock mag-

neism to paleomagnetism; interesting examples of recognition of CRM and VRM; useful

formation stored in secondary components

lens encountered in determining pake

himetry Measurements (O and G)

sity; and applications to biomagnetic phe-

Oceanographic and Geodetic Research With

Papers discussing current research in this area are solicited. Overviews and updates of

fuure satellite altimeter missions (e.g., GEO-SAT and TOPEX) will be presented in invited talks. Abstracts, in standard AGU format,

should be sent by August 31 to C. J. Kob-linsky, Mail Code A-030, Scripps Institution

of Oceanography, La Jolla, CA 92093 (tele-phone: 619-452-4775). In addition, send the

original and two copies of the abstract by September 14 to AGU Fall Meeting, 2000

September 14 to AGO Pan Bissessing, DC Florida Avenue, N.W., Washington, DC

ancisco.Dec.5.

HOTEL ACCOMMODATIONS

PARTICIPATING HOTELS

Van Ness at Geary Street (900) 227-4730

(415) 441-4000

Grosvenor Inn

(415) 673-7411

50 8th Street

(415) 626-6103

Holiday Inn Golden Gateway 1500 Van Ness Avenue

Van Ness and Geary Street

Hollday Inn Civic Center

ROOM RATES FOR ALL HOTELS

PARKING: Cathedral Hill Hotel; free to registered guest

All hotel reservations must be made on the housing form

by November 1, 1983. No telephone requests will be

registrants by the individual hotels. After confirmation

has been received, changes and cancelations should be

accepted. Confirmations will be mailed directly to

Holiday Inn Golden Gateway; free to

San Franciscan Hotel; free to registered

Suites available upon request

registered guest

Mail your completed form directly to:

San Prancisco Housing Bureau

San Franciscan Hotel

1231 Market Street

(415) 626-8000

Single \$47

Twin \$53

Double \$53

made directly to the hotel.

Housing Coordinator
AGU Fall Meeting

P.O. Box 5612

Registration for 1 day only is available a one half the above rates, either in advance at the meeting. Members of the America Meteorological Society, the American Society of Photogrammetry, the European Geophy cal Union, Union Geofisica Mexicana, and the American Congress on Surveying and Mapping may register at the AGU member

The difference between member (or sudent member) registration and nonmember registration may be applied to AGU member ship dues if a completed membership apple tion is received at AGU by February 10,

To preregister, fill out the registration form, and return it with your payments AGU by November 10. Your receipt will be included with your preregistration materials the meeting. Preregistrants should pick up their registration material at the registration desk at the Cathedral Hill Hotel. Hours are A.M. to 4 P.M., Monday through Saturday On Sunday, December 4, registration hours are 5:30 to 7:30 P.M.

Hotel Accommodations

Blocks of rooms (\$47 singles, \$53 doubles are being held at the Cathedral Hill the Holiday Inn Golden Gateway, the Holiday Inn Civic Center, the San Franciscan, and it Grosvenor Inn for those attending. Read the housing application, and mail the complete application form to the housing bureautals to ensure reservations at your preferred be the Housing Coordinator, AGU Fall Media, San Francisco Housing Bureau, P.O. Box 5612, San Francisco, CA 94101. Do not said housing resorvation forms to the hotels.

Reservations must be received by November I to be confirmed. Do not write or all AGU for 100m reservations.

Free parking is available only to registed guests of each horel as indicated.

Scientific Sessions

The Call for Papers, including specifica-tions for abstracts, was published in the Just 28 and July 26 issues of Eas. The program summary will be published in the October Eus. The preliminary program along with the abstracts will be published in the Novembers Eas. The final program, with presentation times, will be distributed at the meeting S entific sessions will be held at the Cathedra Hill and the Holiday Inn Golden Gateway

New Special Sessions

Atmospheric Sciences (A)

Thunderstorm Dynamics and Electricity Lightning
Cooperative Convective Precipitation Experiment (CCOPE)

EL Niño 1982-1983 (cosponsored with 0)

Ocean Sciences (O)

CODE/SUPER-CODE/OPUS Subscabed Disposal of Nuclear Waster: Sae Assessment El Niño in the California Current System

Tectonophysics (T)

Deep Fault Zone Drilling Problem Solving with Rock Magnetic Tech Paleomagnetism and West Coast niques: A Workshop

Session Highlights

See the June 28 and July 26 issues of Es for descriptions of other special sessions Paleomagnetism and West Coast Teclorics

Because there is much to be learned from setting one's results in a larger framework this session will encompass any part of the western Americas from Point Barrow to Cap Horn and from well inboard to well inboard to the process. Horn and from well inboard to well discovered to the present continental margin. The proof the present continental margin. The proof terranes and plates as demonstrated by leomagnetic evidence (e.g., plate motion models, regional geologic studies, etc.) the provide important constraints on large state displacement and in situ rotation of allocate consults terranes. onous terranes.

Problem Solving with Rock Magnetic Techniques: A Workshop (GP)

El Niño in the California Current System

Observations of the California Current during 1982-1983 show several anomalous conditions: warm sea surface temperatures major depression of the thermocline, and nunced subsurface warming relative to orical data. The anomalies are coincident with the 1982-1983 equatorial El Niño. This session encourages both observational and theoretical papers which document the strength of the 1982-1988 event and interpret the observations in terms of either direct or remote large-scale air-sea interactions. Results that show the effect of these anomalous, large-scale processes on small scale or mesoscale processes in the California Current also are encouraged. For more information, contact session chairman J. J. Simpson, Scripps Institution of Oceanography, A-030, La Jolla, CA 92093. Send the original and two copies

of the abstract by September 14 to AGU Fall Meeting, 2000 Florida Avenue, N.W., Wash-

ington, DC 20009.

Meetings (cont. on p.512)

FIELD TRIP FORM

I wish to attend the Franciscan Nano-terrane field trip on Sunday, December 4. My check for \$25 is enclosed.

In case I am not among the first 40:

🔲 I wish to be put on the waiting list. (If you don't go, money will be returned on the day of the trip.)

☐ I wish my money returned.

Mail form to: M. C. Blake, Jr., Mail Stop 75, U.S. Geological Survey, 345 Middlefield Road, Menlo Park, CA 94025

American Geophysical Union S FALL MEA 1983 FALL MEETING HOUSING REGISTRATION FORM The City READ CAREFULLY and RETURN FORM DIRECTLY TO THE SAN FRANCISCO HOUSING **BUREAU AT THE FOLLOWING ADDRESS:** by the Bay Housing Coordinator AGU Fall Meeting

Please print or type all information, abbreviating as necessary. Confirmation will be sent by the hotel to the individual named in Part 1. If more than one room is required, this form may be photocopied.

SF Housing Bureau P.O. Box 5612

San Francisco, CA 94101

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Part II

INSTRUCTIONS: Select THREE Hotels of your choice from the list of participating facilities, then enter the name on the lines below.

Third Choice

NOTE: Rooms are assigned on a "First Come, First Served" order, and if none of your choices are available, another facility will be assigned based on a referral system. A cut-off date is in effect; your application may not be processed if received after 14 days prior to your arrival date. AGU housing registration deadline is November 1.

Part III

INSTRUCTIONS: 1. Select type of room desired with arrival and departure dates. 2. PRINT or TYPE names of ALL persons occupying room.

3. If more than two persons share a room, check twin and the hotel , will assign two double beds.

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IMPORTANT NOTE: Hotel MAY require a deposit or some other form of guaranteed arrival. If so, instructions will be on your confirmation form.

RETURN THIS FORM WITH PAYMENT TO:

Meeting Registration American Geophysical Union 2000 Florida Avenue, N.W. Washington, D.C. 20009

PLEASE PRINT CLEARLY

-

Telephone # . HOTEL Days you plan to attend Please check the appropriate box(es)

□ Dec. 6 Dec. 7 Dec. 8 □ Dec. 9 Dec. 10 Please check a Members of the cooperating societies may register at AGU

Member budges are blue on white Nonmember badges are red on white ☐ Member AGU ☐ Nonmember Member cooperating society

AMS-American Meteorological Society ASP-American Society of Photogrammetry ACSM-American Congress on Surveying and Mapping

EGU-European Geophysical Union UGM-Union Geofisica Mexicana

Nonmembers

The difference between member (or student member) registration and nonmember registration may be applied to AGU dues if a completed membership application is received at AGU by February 10, 1984.

Preregistrants

Your receipt will be in your preregistration packet. The registration fee will be refunded if written notice of cancelation is received in the AGU office by November 28. The program and meeting abstracts will appear in the November 8 issue of Eos.

AGU 1983 FALL MEETING DECEMBER 5-10 San Francisco, California

REGISTRATION FORM Deadline for Receipt of

Preregistration NOVEMBER 10, 1983

licable only if received by November 10 with payment

	More than one day	One day
MEMBER	☐ \$65	□ \$32.50
STUDENT MEMBER	\$32	□ \$16
RETIRED SENIOR MEMBER NONMEMBER	S32	□ \$16
STUDENT NONMEMBER	\$90	□ \$45
OTOBERT HOMMEMBER	🗆 \$41.50	520.75

SECTION LUNCHEONS/DINNER

Circle section and indicate number of tickets. All lunches begin at noon. SPR dinner begins at 6:30 P.M.

 Planetology/Volcanology, Geochemistry and Petrology, Tuesday, \$9 _ Seismology/Tectonophysics, Tuesday, \$5

- Geomagnetism and Paleomagnetism, Wednesday, \$5 ----- Hydrology, Wednesday, \$9 ---- Ocean Sciences, Wednesday, \$9 _ Solar-Planetary Relationships, Wednesday,

\$20 (dinner) ____ Atmospheric Sciences, Thursday, \$9 - Geodesy, Thursday, \$9

Total Enclosed \$_ (All orders must be accompanied by payment or credit

card information. Make check	payable to AGU.)
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	3 1			<u> </u>

The purpose of this session will be to pre-sent special applications of rock magnetisms

San Francisco, CA 94101